



CONCRETE PAVEMENT TECHNOLOGY

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GUIDELINES FOR PROTECTION AND REPAIR OF CONCRETE PAVEMENTS EXPOSED TO RAIN DURING CONSTRUCTION

PURPOSE

This publication is written to provide guidance for adequate protection of concrete pavements in the event rain occurs during construction and to establish guidelines for repair and acceptance of areas of pavement subjected to rain during construction.

DESCRIPTION

Highway contractors have completion dates to meet; therefore, they must pursue construction work to meet these dates and avoid liquidated damages or penalties. Concrete paving contractors likewise cannot afford to await ideal weather to construct pavements. They must actively pursue the construction of pavements in order to meet the schedule of other phases of the construction contract so that the completion dates can be met.

One nemesis of the concrete paving contractor is rain. When rain occurs, it plays havoc with the paving schedule by creating problems with haul roads, subgrade, subbase, and stockpiled materials as well as concrete placement and finishing. However, the paving contractor must utilize all potential paving time, including days when rain may occur, rather than await ideal weather conditions.

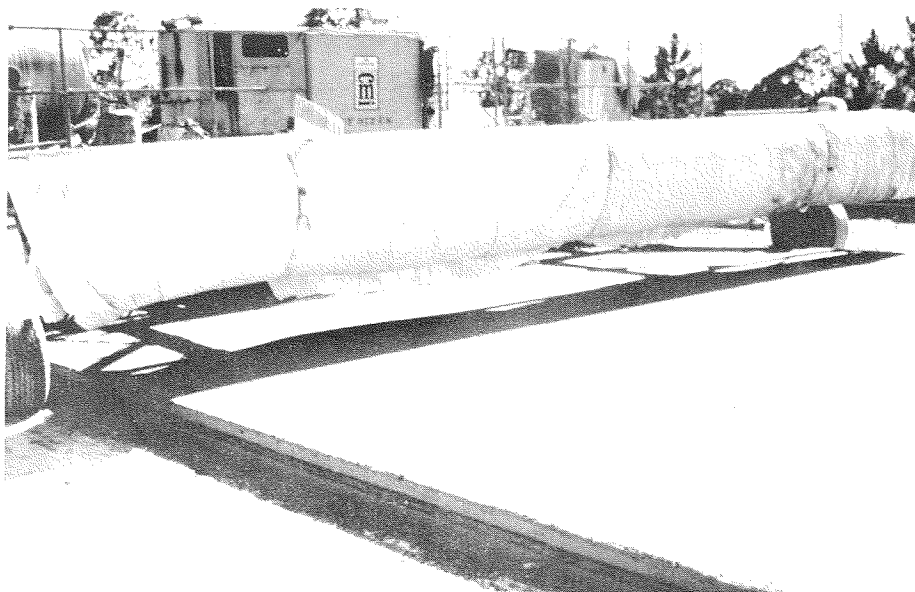
Procedures are outlined in this guideline to protect the unhardened concrete when rain occurs; but in-

evitably there will be some areas of pavement that will be subjected to rain before they can be properly finished, textured, and cured. The acceptance of these areas is a dilemma that confronts the contractor and the specifying agency. Should the concrete be accepted in the condition existing after exposure to rain, or should some other corrective action be taken to repair the pavement? Adherence to the procedures contained herein for correcting areas subjected to rain should provide pavement that is acceptable and avoid the dilemma of how to resolve this problem.

Climatic conditions during a rain are not harmful to concrete. Just the

opposite - the conditions are conducive to attainment of the greatest ultimate strength and durability of the concrete. Mix water necessary for hydration is not lost through evaporation from the concrete. Moderate temperatures accompanying rain generally provide more favorable curing conditions when compared to high temperatures. Therefore, the conditions existing during a rain are not detrimental to concrete unless adequate procedures are not followed to protect the concrete.

Investigations have shown that pavement and bridge surfaces subjected to rain are durable and have good skid resistance. Higher skid numbers have been measured on



"An ounce of prevention," — Rolls of polyethylene plastic sheeting are carried by many ACPA contractors on their texturing/curing equipment to minimize rain damage to new pavements.

rained-on surfaces than on adjacent surfaces that were not subjected to rain. These higher skid numbers were obtained both initially and after several years of service. This same relationship was observed when comparing surfaces that were retextured after being rained on to adjoining surface areas that were not affected by rain. Therefore, rain is not necessarily detrimental to the skid resistant properties of a concrete surface.

Durability, determined by observation and by measurement of the entrained air content of the hardened concrete at the surface, is not adversely affected by rain. Pavement surfaces are still in tact after years of service and still contain minor surface imperfections caused by the covering material and the direct result of rain, further attesting to the durability of rained-on surfaces. Adoption of the procedures in this guideline will assure attainment of quality pavement surfaces.

MATERIALS

The contractor shall have protective covering and side forms or boards available at all times to protect the surface and edges of the newly placed concrete pavement when it rains. Rolls of protective covering shall be installed on the paving equipment to permit rapid application when rain occurs or they shall be located at the construction site and moved to the placement area when rain appears likely. Rolls of protective covering of sufficient length, width, and thickness to adequately protect the pavement and edges may be used without the temporary side forms or boards if properly anchored to protect the unhardened slab and edges.

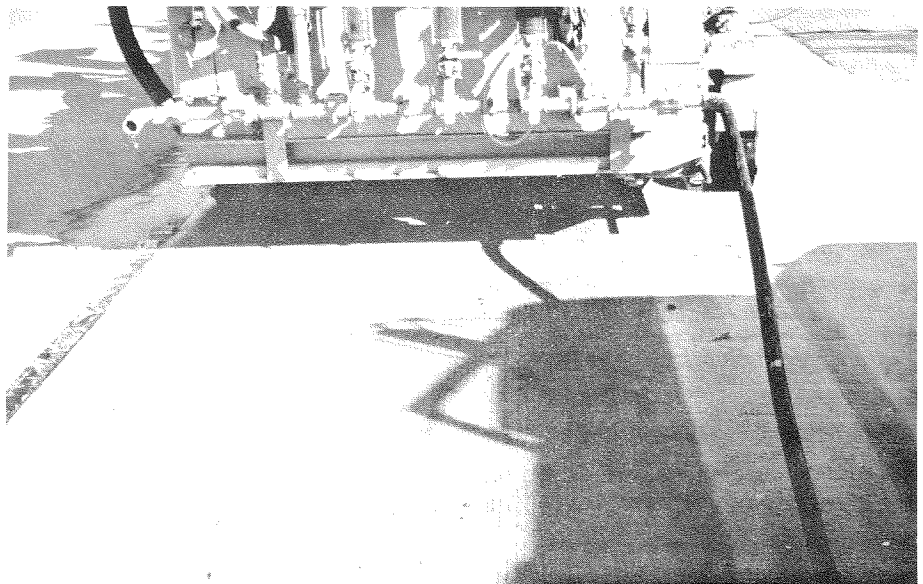
Polyethylene, burlap, or any cover that can be readily applied and will protect the pavement surface from the rain will be acceptable protective material. Polyethylene is the most practical material currently available since it can be used many times and

can be quickly installed.

If side forms are deemed necessary to protect pavement edges, they may be of wood or steel and must have a depth not less than the thickness of the pavement.

PROCEDURE

Prior to commencing paving operations it is recommended that the details of this guideline be reviewed by the contractor and the specifying agency to assure that procedures to be followed in the event of rain are clearly understood and are implemented.



Longitudinal or transverse safety grooving will ensure adequate skid resistance on many rain damaged sections where the texture has been eroded away.

When rain occurs all mixing and batching operations shall stop, and all available personnel shall begin covering the surface of the unhardened concrete with the protective coating. The length of pavement to be protected will be dependent upon the rate of paving, the setting time of the concrete, and the intensity of the rain. Therefore, the length will vary. A "rule of thumb" is to cover the pavement back to the point where the rain is not indenting the surface of the pavement. The covering need not be extended to areas where the rain is washing the curing membrane from the pavement but is not indenting the surface.

Side forms shall be installed in those areas of pavement constructed by the slipform method where the edge cannot otherwise be protected to prevent severe edge erosion. Side forms should also be installed in those areas where the surface has required extensive remedial work after the rain ceases. This will prevent excessive edge slump.

REMEDIAL WORK WHEN RAIN CEASES

If the concrete is still workable when the rain ceases, the protective covering shall be removed imme-

diately and remedial measures completed before resuming paving operations. Most protective covers retain the heat of hydration of the concrete and accelerate the setting time. Therefore, it is imperative that the covering be removed and the corrective work begun immediately.

Care shall be exercised to prevent water accumulated on the protective cover from getting on the surface. Any water that remains on the pavement surface shall be carefully removed with straightedges or by use of a pipe float machine or any method that will not incorporate the water into the concrete.

Areas of the pavement surface

where the texture has been damaged by the protective cover shall be retextured and cured unless the concrete has hardened.

Areas of pavement surface that exhibit a smooth sandy appearance after the rain ceases shall be textured and cured. An attempt shall be made to impart the specified texture to these areas before applying the membrane curing material.

Areas that have suffered some surface erosion and have coarse aggregate exposed shall be reworked by hand methods or with the finishing equipment. Fresh concrete containing the same materials and properties as the pavement concrete shall be added to maintain an adequate supply in front of the screeds or machine to assure replacement of the concrete eroded from the surface. The surface shall then be textured and cured as specified.

If pavement edges have been severely eroded and the concrete has not set, the edges shall be repaired by setting side forms and replacing eroded concrete. After the side forms are set, fresh concrete shall be placed and finished prior to texturing and curing.

CORRECTIVE WORK AFTER CURING PERIOD HAS ENDED

When rain persists for prolonged periods, the concrete may take its final set before it can be properly finished and textured. After the pavement has hardened, remedial work shall not be permitted. Areas that do not comply with requirements for smoothness, texture, and edge slump shall be corrected after the curing period has terminated.

Occasional edge slumping up to 1/2 inch in the outer 2 feet of a lane that will not be adjacent to another lane or a speed change lane will not be detrimental to pavement performance or service and, therefore, will not require corrective work. Corrective work shall be performed to satisfy the following guideline

requirements.

Areas that exceed the specified surface smoothness tolerance and areas that could not be properly textured shall be corrected by grinding, texturing, or grooving using concrete grinding machines. The equipment shall impart a groove or texture pattern similar to that specified for new pavement. In most cases, longitudinal safety grooving will be an acceptable alternative.

When grooving is permitted, the grooving pattern shall be 1/8 inch deep by 1/8 inch in width and spaced 3/4 inch on centers. Grooves shall be cut parallel to the centerline. In areas where frequent braking occurs, consideration could be given to cutting the grooves transversely. Texturing as specified for new pavement shall be imparted to those areas that were not properly textured. Safety grooving may be permitted for these areas in lieu of texturing.

Grinding, texturing, and grooving shall be delayed until the pavement has reached the strength specified for opening to construction traffic or seven days, whichever is less.

Pavement edges that have been severely eroded and could not be repaired before the concrete hardened shall also be corrected anytime after the curing period has expired. Where

pavement lanes, concrete shoulders, or curb and gutter are to be constructed adjacent to the eroded edges, a new existing edge can be created by making a full-depth saw cut parallel to the planned pavement edge and a sufficient distance in from the edge to remove all unsatisfactory eroded edges.

The lane width for new adjacent concrete shall be wider than planned to compensate for the amount removed from the edge. The overall pavement width shall be unchanged, the only deviation from the plan being an offset in the longitudinal construction joint in those areas that suffered severe edge erosion. Holes shall be drilled and tiebars or hookbolts installed using an expanding grout or epoxy before constructing adjacent lanes.

If the edge erosion is severe and there isn't an adjacent concrete section, it may be necessary to remove all or a portion of a lane and reconstruct it. If a portion of a lane width is removed, a full-depth saw cut shall be made parallel to the planned edge and a minimum of 2 feet from it. If it is necessary to remove more than 2 feet in width, the entire lane shall be removed. Holes shall be drilled and tiebars or hookbolts installed using an expanding grout or epoxy.



In extreme circumstances where the texture has been severely eroded away from heavy rains on the plastic concrete, diamond grinding of the sections will restore the surface texture and ride.

Concrete shall be replaced and the surface properly finished, textured, and cured. Similar repairs have been in service for over 20 years on an interstate route without requiring unusual maintenance.

Another method of correcting severe edge erosion is to place a bonded patch similar to a bonded concrete overlay. A 1½ inch deep saw cut can be made near the eroded edge to outline the extent of the erosion. After removal of the concrete from this area, a form is placed and a bonding grout of sand-cement or epoxy is applied to the concrete. Concrete can then be placed to restore the edge.

If the edge erosion is not severe, it may be repaired by bonding concrete or epoxy mortar to the effected areas using accepted procedures outlined by the engineer.

ACCEPTANCE

Rain is not detrimental to the quality of concrete pavement if appropriate action is implemented to protect and correct the unhardened concrete pavement. Prior planning and immediate action are mandatory to minimize the effects of rain. Using procedures outlined here-in should provide a completed pavement acceptable in all respects and expected to provide the service life for which it was designed. Pavement protected and corrected by these procedures shall be eligible for full payment at the contract bid price.

SUPPLEMENT - FIELD PERFORMANCE OF RAINED-ON PAVEMENTS

Sections of concrete pavement have been and will continue to be exposed to rain during construction. The performance of these sections of pavement is of concern to both the specifying agencies and contractors.

The following examples will serve to illustrate that rained-on pavements are not necessarily damaged. Rained

on sections will have about the same characteristics as adjacent sections of pavement. The examples will also illustrate that remedial measures can be taken during construction or corrective measures performed after the concrete hardens to obtain a pavement surface with adequate durability and skid resistance.

EXCERPTS FROM OHIO DEPARTMENT OF TRANSPORTATION REPORT

On September 8, 1970, a super-elevated section of the eastbound lanes of SR 16 immediately west of SR 146 incurred rain damage between stations 670 ± and 677 ±. A heavy rain occurred approximately 45 minutes following shutdown of paving operations. The rain caused some surface erosion and rutting, and the required longitudinal texture was washed away. In order to correct the surface condition existing after the rain, it was decided to use a concrete grinding machine with diamond saw blades on the hardened concrete to restore the desired texture and smoothness. Subsequent skid tests and observations indicate that there is no visible difference in surface durability or measured skid resistance between the treated area and the adjacent normal pavement. Pavements which are severely damaged by rain can usually be restored to acceptable skid resistance values and surface profile with this type of corrective action.

A section of pavement (stations 225 ± to 270 ±) on the outside west-bound lane of I-70 at the Hilliard-Rome interchange in Columbus constructed in 1969 was exposed to rain during construction. The contractor was able to cover a majority of the plastic concrete with polyethylene; however, there is approximately 1,500 feet of pavement exhibiting the characteristic of a rain textured surface.

There was no indication of any surface durability problems during the

service life of the pavement. Routine skid testing has been conducted on the interstate pavement in this area since 1970. These tests have revealed that the rained-on pavement had a higher initial skid number than the adjacent sections, and subsequent testing indicates that the rained-on pavement still maintains a higher level of skid resistance. This phenomenon has been reported on several sections of rained-on pavement in other parts of the country.

EXCERPTS FROM IOWA CONTRACTOR'S REPORT

A four-lane formed paving project was constructed in Madison County, Iowa, in 1958. For five consecutive days, every header was set in the rain. Sections of the pavement were severely damaged by the rain, and immediate remedial action was taken to restore the surface which had been eroded exposing the coarse aggregate.

Observation of this pavement over several years reveals that there is no visible damage evident; and the rained-on pavement is performing as well as the adjacent lane which was not exposed to rain. This example illustrates that remedial work can be undertaken to restore pavement surfaces severely damaged by rain and arrive at a durable surface which will withstand the environmental conditions of a severe climate.

KEYWORDS: Concrete finishing, concrete pavements, quality control, skid resistance, slipform construction, specifications.

SYNOPSIS: Recommendations are made regarding adequate protection of concrete pavement construction during rain and acceptance of areas of pavement subjected to rain during construction. Case histories are included to illustrate the results of various remedial or corrective measures taken to restore acceptable surfaces to severely rain damaged pavements.